Effects of body weight on antibody titers against canine parvovirus type 2, canine distemper virus, and canine adenovirus type 1 in vaccinated domestic adult dogs

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Abstract

The objective of this study was to determine whether post-vaccination antibody titers vary according to body weight in adult dogs. Antibody titers against canine parvovirus type 2 (CPV-2), canine distemper virus (CDV), and canine adenovirus type 1 (CAdV-1) were measured for 978 domestic adult dogs from 2 to 6 y of age. The dogs had been vaccinated approximately 12 mo earlier with a commercial combination vaccine. The dogs were divided into groups according to their weight. It was found that mean antibody titers in all weight groups were sufficient to prevent infection. Intergroup comparison, however, revealed that CPV-2 antibody titers were significantly higher in the Super Light (< 5 kg) group than in the Medium (10 to 19.9 kg) and Heavy (> 20 kg) groups and were also significantly higher in the Light (5 to 9.9 kg) group than in the Heavy group. Antibody titers against CDV were significantly higher in the Super Light, Light, and Medium groups than in the Heavy group. There were no significant differences among the groups for the CAdV-1 antibody titers.

Résumé

Pour vérifier que les taux d'anticorps chez des chiens vaccinés changeaient en fonction de leur poids après la vaccination par un vaccin commercial combiné, on a mesuré les anticorps antivirus de la parvovirose canine (CPV-2), de la maladie de Carré (CDV) et de l'encéphalite de Rubarth — type-1 (CAdV-1) chez 978 chiens de compagnie agés de 2 à 6 ans, un an après leur vaccination. Par nos mesures, nous observons dans tous les groupes un taux satisfaisant d' immunisation moyen des animaux. Mais en comparant les groupes de poids, on s'aperçoit que pour la parvovirose canine CPV-2, le groupe des super-légers (< 5 kg) est significativement plus protégé en anticorps que les groupes de poids moyen (de 10 à 19,9 kg) et de poids le plus lourd (> 20 kg). De même les poids légers (de 5 à 9,9 kg) sont significativement mieux protégés que les poids lourds. Pour la maladie de Carré (CDV), les super-légers, les poids légers ou les groupes de poids moyen ont un taux d'anticorps significativement plus élevé que les plus lourds. Par contre pour l'Encéphalite de Rubarth (CAdV-1) aucune différence des taux d'anticorps dans les groupes de poids n'a été observée.

(Traduit par les auteurs)

Canine parvovirus (CPV) infection, canine distemper, and infectious canine hepatitis (ICH) are important, highly infectious and fatal canine diseases caused by canine parvovirus type 2 (CPV-2), canine distemper virus (CDV), and canine adenovirus type 1 (CAdV-1), respectively (1–3). There is still no effective treatment for these infectious diseases and the only way to protect individual dogs and prevent epidemics among dog populations is to strictly enforce vaccinations.

Immunizing dogs against these 3 infectious diseases through vaccination is therefore crucial to prevent outbreaks. Vaccination protocols have been established based on the experience of pioneers in the field and the results of challenge infection testing by vaccine manufacturers. These protocols state that the vaccine dose should be the same for all dogs, regardless of their size. Unlike other animals treated by veterinarians such as cats and larger animals including cows, pigs, and horses, the body weight of adult dogs varies considerably among the breeds. It is therefore reasonable to expect that the antibodies acquired by these dogs may also differ. The present study groups domestic adult dogs vaccinated with conventional, commercial combination vaccines according to their body weight and examines whether there is a difference in their antibody prevalence against CPV-2, CDV, and CAdV-1.

Subjects were 978 domestic adult dogs vaccinated 11 to 13 mo before the study with commercially available combination vaccines containing CPV-2, CDV, and CAdV-2. Based on the findings of previous studies that antibody titer differs according to age, the dogs used were from 2 to 6 y of age. Of these animals, 406 were sexually intact males and 123 were castrated males, while 241 were sexually intact females and 208 were sterilized females. Dogs were sorted into the following 4 groups: Super Light (< 5 kg, n = 255); Light

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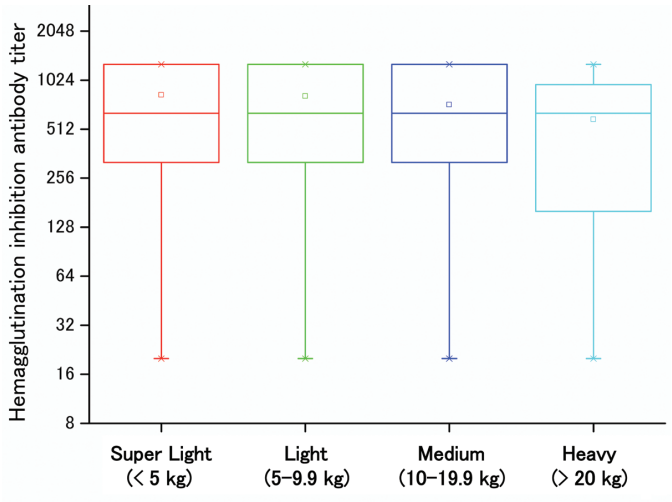

Figure 1. Mean reciprocal antibody titers against CPV-2 appearing in the box plot were 1:829 for the Super Light group, 1:817 for the Light group, 1:722 for the Medium group, and 1:588 for the Heavy group.

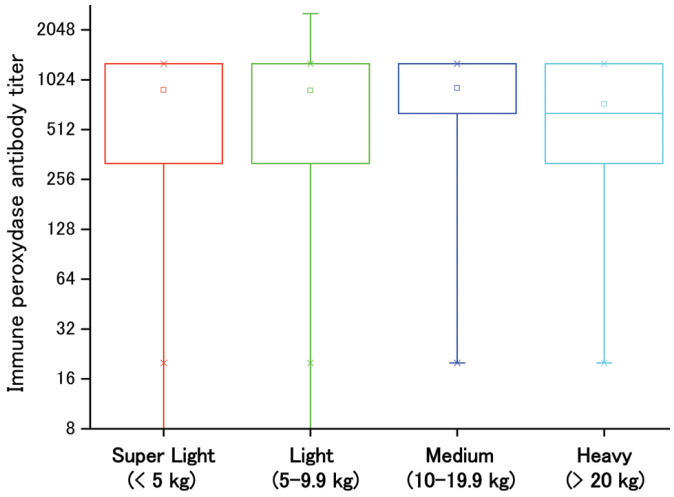

Figure 2. Mean reciprocal antibody titers against CDV appearing in the box plot were 1:886 for the Super Light group, 1:881 for the Light group, 1:912 for the Medium group, and 1:729 for the Heavy group.

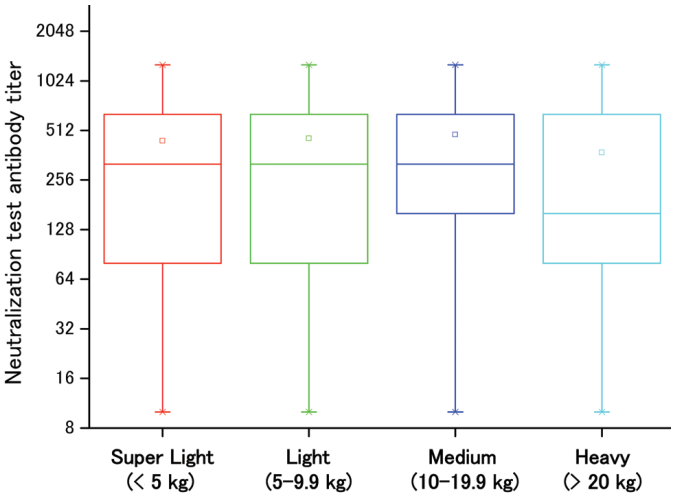

Figure 3. Mean reciprocal antibody titers against CAdV-1 appearing in the box plot were 1:442 for the Super Light group, 1:457 for the Light group, 1:482 for the Medium group, and 1:376 for the Heavy group.

(5 to 9.9 kg, $n = 324$); Medium (10 to 19.9 kg, $n = 267$); and Heavy (> 20 kg, $n = 132$).

Serum samples collected before vaccination were isolated and sent frozen to Marupi Lifetech, a commercial veterinary diagnostic laboratory in Osaka City, Japan, to be measured. Antibody titers for CPV-2 were obtained by the hemagglutination inhibition (HI) test, CDV antibody titers by the immune peroxidase (IP) test, and CAdV-1 antibody titers by the neutralization test (NT).

Antibody titer classification used the established criteria of the commercial veterinary diagnostic laboratory, based on previous reports indicating the protective titer. The antibody titer that protects against disease was designated as the borderline-titer antibody, Borderline. The 4-fold higher titer than Borderline was designated as High, based on the previous observation that titer decreased to one-fourth in 1 y (4).

Many early reports have shown that 1:80 is a protective titer against CPV-2, but an older type of antigen may have been used for the titration test in these studies (4,5). For the present study, 1:40 was designated as Borderline because CPV-2b, a newer antigen, was used and a level of 1:40 was determined in a challenge infection study at another laboratory (technical information on Rescamune P-ML; Nippon Zenyaku Kogyo). High was designated as ≥ 1:160.

Other reports have shown that Borderline protective titer against CDV is 1:32, as determined by NT (5–7). In this study, however, the IP test was used for titration and 1:160 was selected as the minimum of Borderline based on regression analysis between NT and IP. High was designated as ≥ 1:640.

As an antibody titer of 1:32 to 1:42 against CAdV-1 was the most reliable value previously reported (8), Borderline was designated as 1:40 and High was designated as ≥ 1:160. Antibody titers that had no endpoint at a dilution of 1:1280 were given a value of 1280.

The distributions of CPV-2, CDV, and CAdV-1 antibody titers were depicted for each weight group using box plots (Figures 1 to 3). Statistical differences were then determined by Mann-Whitney U test to determine whether the CPV-2, CDV, and CAdV-1 antibody titers were the same in each weight group, and were subsequently tested using the Bonferroni correction. Statistical significance was set at $P < 0.05$.

Figure 1 depicts the CPV-2 antibody titers in each of the 4 weight groups. The plot shows that mean antibody titer tended to decline as body weight increased. Intergroup comparison revealed that antibody titers were significantly higher in the Super Light group than in the Medium and Heavy groups and were also significantly higher in the Light group than in the Heavy group (Table I).

Figure 2 shows the distribution of antibody titers to CDV for each weight group. As was the case for CPV-2, mean antibody titer tended to decline as body weight increased. Intergroup comparison indicated that mean antibody titers against CDV were significantly higher in the Super Light, Light, and Medium groups than in the Heavy group (Table I).

Figure 3 shows the distribution of antibody titers to CAdV-1 for each weight group. No significant differences were observed among the groups.

Table I. Significance testing between weight groups

	CPV-2 Medium	CPV-2 Heavy	CDV Heavy
Super Light	0.036	4.6E-06	0.025
Light	NS	6.7E-05	0.026
Medium		NS	0.004

Significant differences in CPV-2 antibody titers were seen between the Medium and Super Light groups, and between the Heavy group and Super Light/Light groups. In addition, significant differences in CDV antibody titers were observed between the Heavy group and the three other groups. No significant differences were observed for any of the other combinations.

Numbers indicate *P*-values. NS — not significant ($P > 0.05$).

The HI test antibody titer to CPV-2 was 1:829 in the Super Light group, 1:817 in the Light group, 1:722 in the Medium group, and 1:588 in the Heavy group. The IP test antibody titer to CDV was 1:886 in the Super Light group, 1:881 in the Light group, 1:912 in the Medium group, and 1:729 in the Heavy group. The NT antibody titer to CAdV-1 was 1:442 in the Super Light group, 1:457 in the Light group, 1:482 in the Medium group, and 1:376 in the Heavy group. The antibody titers therefore exceeded the High classification in all weight groups.

Of the 978 dogs subjected to antibody titer measurement, anaphylaxis occurred in 1 dog (CPV-2 — 1:1280; CDV — 1:20; CAdV-1 — 1:40) and depression occurred in 1 dog (1:1280; 1:20; 1:160) after vaccination.

In small animal practice, therapeutic agents are administered at doses based on body weight and body surface area, but vaccines are administered at constant doses regardless of body weight because they are meant to stimulate the immune system. According to a study of antibody titers obtained after vaccination with commercial inactive rabies vaccines, antibody titer tended to increase as body weight declined for both vaccines (9). While CPV, CDV, and CIH are all treated with viable attenuated vaccines, the rabies vaccine is seen as having a different antibody production mechanism. Even if good immunity could be obtained for beagles of a certain size used in vaccine efficacy testing, it is possible that the antigen level may be deficient or excessive according to dog size.

Furthermore, rottweilers, American pit bull terriers, Doberman pinschers, and German shepherd dogs are said to have an increased risk of CPV-2 infection (10). These very large dog breeds are scarce in Japan and were not included in the present study. While we cannot make a comparison, we regard this finding as being associated with the results of the present study that antibody titers are lower in large dogs than in small dogs after vaccination. Several studies on post-vaccination adverse effects (AEs), such as allergic reaction, anaphylaxis, urticaria, and cardiac arrest (11,12), have attributed these effects to vaccine-related factors, including antigens, adjuvants, and diluents (13–15). Another study points to the dog-related factor of high AE incidence in dogs with low body weight such as dachshunds, pugs, Boston terriers, miniature pinschers, Chihuahuas, Maltese, miniature schnauzers, Jack Russell terriers, toy poodles, and Yorkshire terriers (11). This latter finding is consistent with the present study's result of elevated CPV-2 and CDV antibody titers in small dogs.

While large domestic dogs are scarce in Japan, small breeds of dogs are popular due to the influence of mass media and because they are better suited to indoor environments. Unlike cows, pigs, and cats, body weight differs markedly among dog breeds, so the existing method of administering the same vaccine dose for all dogs, regardless of body weight, may need to be reconsidered. The data obtained from the present study indicating that antibody titers against CPV-2 and CDV are low for large dogs and high for small dogs should therefore prove useful in compiling future vaccination protocols.

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